EP65-51

(When Filled In)

TRANSMITTAL OF DRAFT REPORT FOR REVIEW AND PUBLICATION

PROJECT NO. 26.4415

TO : Chief, Economic Research Area
THRU: Chief, Planning and Review Staff

TITLE, OR SUBJECT, OF REPORT

Investment, Operating Capacity, and Production of Electric Power in the Czechoslovak Electric Power Industry

25X1A

CONTRIBUTING ANALYST(S)

[redacted]

ATTACHMENTS: ORIGINAL AND TWO COPIES

RECOMMENDED PUBLICATION CATEGORY: ER [ ] RA [ ] EM [ ] CG [X] OTHER: EP 65-57

COORDINATING ANALYSTS

NAME	BRANCH	INITIALS
[redacted] 25X1A	A/E	ME

GRAPHICS TO BE PUBLISHED IN TEXT: [X] YES [ ] NO

HAS CLEARED ST/P GRAPHICS COORDINATOR: [ ] YES [X] NO

INFORMATION ON US MILITARY END PRODUCTS AND MANPOWER USED: [ ] YES [X] NO

NO. OF MANHOURS TO PRODUCE REPORT: 200

ESTIMATE CARDS SUBMITTED TO ST/P/A: [ ] YES [ ] NO

AUTHOR'S NAME REQUESTED TO APPEAR ON REPORT: [ ] YES [X] NO

DATE: 16 June 1965

SIGNATURE OF AUTHOR: [redacted] 25X1A

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THE ATTRIBUTION OF THIS REPORT TO AUTHOR IS: [ ] APPROVED [ ] DISAPPROVED

COMMENTS

An unusually well designed study which updates and analyzes more intensively the data on electric power in A/E's earlier study, Investment, Fixed Assets and Output in Czechoslovak Industry, ER 61-39.

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With by [redacted] on draft — consider complete - no publication would have no objection to running off 10-12 copies for special distribution if branch wishes to do so. 28 June 65

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Investment, Operating Capacity, and Production in the Czechoslovak Electric Power Industry 1954 - 1964

CIA/RR EP 65-57

11 June 1965

Foreword

Numerous articles in the Czechoslovak press in 1963 testified to a shortage of electric power. In that year not only were plans for production of electric power (and for industry in general) underfulfilled, but there was also a noticeable decrease in the rate of growth. This slowdown occurred in spite of apparently adequate investment in the electric power industry. The present memorandum discusses the causes of the apparent shortage of electric power in 1963 and the lower rate of growth in production of power. It also examines the possibility that continuing operation of these causes would bring recurrent shortages and slower rates of growth in the future.

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INVESTMENT, OPERATING CAPACITY, AND PRODUCTION OF ELECTRIC POWER IN THE CZECHOSLOVAK ELECTRIC POWER INDUSTRY*

Summary and Conclusions

Cumulative investment, operating capacity, and production of electric power in the Czechoslovak electric power industry** have shown a steady, if sometimes spotty, growth during the past decade. Total operating capacity has grown more rapidly than either cumulative investment or production during the past five years, reflecting increasing efficiencies in capital inputs and increasing reserves of operating capacity. Generally speaking, each 1 percent increase in cumulative investment has been accompanied by a 1.1 percent increase in production of electric power. Each 1 percent increase in production of electric power has, however, been accompanied by an increase of only 0.46 percent in the output of industry, the major consumer of electric power. As capacity was growing faster than production, and output of industry much more slowly, the failure to achieve a greater growth in production of electric power would appear to be caused by a slower rate of growth in requirements for power rather than a slower growth in the capability to produce electric power.

* The estimates and conclusions in this report represent the best judgment of this Office as of 15 June 1965.

** The electric power industry in Czechoslovakia is composed of all the power enterprises that maintain an independent set of accounts and produce electric power primarily for the public supply. These enterprises now generate more than 75 percent of the electric power produced in the country. (See Appendix A.)

These long-term trends place in perspective the slowdown in growth of output of electric power in Czechoslovakia that occurred in 1963 — when output increased by only 396 million kwh, remaining 5 percent below both plan and the trend line — and the shortages of electric power that occurred in that year. A 3 percent decline in real industrial output depressed requirements for electric power considerably below the requirements under conditions of normal industrial growth. Offsetting the effect of this decline in industrial production on the output of electric power was a 9 percent increase in the expenditure of electric power per unit of industrial output. Consequently, consumption of electric power by industry grew by 6 percent. It appears, therefore, that the decline in the rate of growth of production of electric power reflected primarily the slowdown in growth of industrial requirements for power. The over-expenditure of electric power was part of the general pattern of reduced efficiencies in Czechoslovak industry in 1963.

The workings of these factors were obscured, however, by a combination of misfortunes in the Czechoslovak electric power industry that brought about shortages of electric power in spite of the fact that requirements for power were much lower than the level that would have resulted from continuation of past trends in the relationship between industrial production and industrial output. Severe winter weather restricted river flows and fuel supplies, cutting the power available to meet peak loads, and using up normal reserves of generating capacity. Malfunctions of

several new 100-megawatt turbogenerators kept reserve capacity below the levels necessary to make up for the reduced generating capability caused by the weather conditions. As a result power shortages developed. If industry had continued to consume the same amount of power per unit of industrial output as in the past, production of power in 1963 would have been sufficient to meet actual requirements. Hence it was the reduced efficiency of industry (resulting in excessive consumption of electric power per unit of industrial output) which, coupled with the misfortunes of the electric power industry, was responsible for the power shortages in 1963.

The difference between the rate of growth in production of electric power by the electric power industry and the rate of growth in net industrial output in 1964 suggests a continued high rate of consumption of electric power per unit of industrial output. (Precise data on consumption of power by industry are not yet available.) The supply apparently was adequate in 1964, however, as there were no complaints of serious power shortages, even in the winter months. Successful operation of a large number of new 110-megawatt generating units in 1964, serial production of these units, prospects for successful operation of 200-megawatt units in 3-4 years, and connection of the Czechoslovak electric power system to the power system of the USSR and other eastern European Communist countries by means of the CEMA network in 1964 indicate that power supply capability will be sufficiently high during the next few years to preclude a recurrence of shortages such as occurred in 1963, even if the severe winter conditions of that year should be repeated. A repetition of the slowdown in growth of power production, however, may occur in any year in which industrial output fails to grow.

I. Long Term Trends in Investment, Generating Capacity, and Production of Electric Power

The development of the electric power industry in Czechoslovakia during the last decade has been characterized by a steady growth in the value of fixed assets plus unrealized investment in uncompleted construction, a spotty but continuous growth in generating capacity and a steady growth — except for 1963 — in the production of electric power.*

During the years 1955-59 the generating capacity of the electric power industry grew at an average annual rate of 10.5 percent, compared to an average annual rate of 10.9 percent in cumulative capital investment (the value of fixed assets in the electric power industry plus the value of uncompleted construction). Production of electric power grew more rapidly, averaging an increase of 11.8 percent per year. Industrial production — the main consumer of electric power — grew at a rate of about 10.0 percent per year. The trends during this period showed reasonable inter-relationships; each 1.0 percent growth in capital input was accompanied by a 1.1 percent growth in production.

During the last five years, 1960-64, generating capacity has grown more rapidly, at an average annual rate of 11.7 percent, compared to an estimated

* Table 1 and Figures 1 and 2 show trends in the value of fixed assets plus the value of uncompleted construction, generating capacity, and production of electric power in the Czechoslovak electric power industry. The value of uncompleted construction has been added to the value of fixed assets in order better to reflect cumulative capital investment in the industry.

Table 1

Czechoslovakia: Selected Indexes for the Electric Power Industry

Year	Fixed Assets Plus Unrealized Investment at the Beginning of the Year		Installed Generating Capacity at the Beginning of the Year		Production During the Year	
	Million Crowns a/ in 1957 Prices	Index	Megawatts b/ c/	Index	Million kilowatt-hours c/ d/	Index
1954	14,840	100	1,836	100	9,029	100
1955	16,370	110	2,078	113	10,257	114
1956	18,150	122	2,580	141	11,600	128
1957	20,500	138	2,712	148	12,362	137
1958	22,660	153	2,865	156	13,777	153
1959	24,870	168	3,024	165	15,780	175
1960	27,080	182	3,707	202	18,168	201
1961	29,560	199	3,940	215	20,377	226
1962	31,810	214	4,587	250	21,936	243
1963	34,470	232	4,885	266	22,332	247
1964	36,970	249	5,269	287	24,229	268

a. Based on a series beginning in 1948. Fixed assets at the end of 1948 were 9,470 million crowns. 1/ Unrealized investment in uncompleted construction at that time is estimated to have been 190 million crowns or 23.6 percent of the 805 million crowns invested in the industry in 1948 2/ (using the same ratio of unrealized investment to total investment as for industry as a whole 3/), plus one-half of the 190 million crowns unrealized in 1948 for an estimated allowance for unrealized investment from 1946 and 1947. Fixed assets plus unrealized investment in uncompleted construction at the beginning of 1949 were thus 9,760 million crowns. Investment in each subsequent year was added to this amount to obtain fixed assets plus unrealized investment. 4/

b. 5/

c. Capacity at the beginning of the year has been compared to production during the year, as this is the capacity available for production during the year. Average capacities could have been derived, but they would not be comparable to the cumulative investment series.

d. Years 1954-63 6/; 1964 7/.

Approved For Release 2000/05/15 : CIA-RDP79T01049A003100110001-4

FIGURE 1 SECRET

CUMULATIVE TRENDS IN INVESTMENT, GENERATING CAPACITY, AND PRODUCTION OF ELECTRIC POWER IN THE CZECHOSLOVAK ELECTRIC POWER INDUSTRY

~~Realized Investment in Unrealized Investment in Fixed Assets plus Uncompleted~~

Cumulative Investment

~~Construction at Beginning of Year~~

Capacity at Beginning of Year

Production During Year

INDEX

330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100

1954 1955 1956 1957 1958 1959 1960 1961 1962 1963

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8.3 percent for the index of cumulative capital investment. Production of electric power has grown at an average annual rate of 8.9 percent, but industrial output at only 3.7 percent a year. Each percent growth in capital input was accompanied by a 1.1 percent growth in production, as in the previous five-year period. During the last five years each 1.0 percent increase in investment in the Czechoslovak electric power industry has brought 1.5 percent growth in generating capacity compared to a 1.0 percent growth in the previous five-year period. Each percentage increase in kilowatt-hours (kwh) generated during the years 1960-64 has been accompanied by an 0.4 percent increase in net industrial output compared to an increase of 0.8 percent in 1955-59. As more capacity was being installed per crown of investment in 1960-64 than in 1955-59, failure to achieve more production per crown of investment would appear to have been caused by a slower rate of growth in power requirements.

When these trends are separated into annual increments, the rather even flow of investment into the Czechoslovak electric power industry stands in sharp contrast to the annual additions to generating capacity, which have fluctuated widely as a consequence of the frequent failure to install capacity as scheduled.* The uneven installation of units results in

* Additions fell from 503 megawatts (mw) in 1955 to 132 mw in 1956, and jumped from 160 mw in 1958 to 633 mw in 1959 to 233 mw in 1960. Capacity installed in 1964 was 787 mw compared to 384 mw in 1963. 8/ Consequently there is no meaningful correlation between investment in the electric power industry and the capacity installed in the same year, the next year, two years later, or any other number of years later.

significant fluctuations in the value of uncompleted construction. In general, however, despite the fluctuations, this unrealized investment has averaged about 11 percent of the value of fixed assets in the industry. No secular trend to a greater proportion of investment tied up in uncompleted projects is discernible. (See Figure 2.)

The uneven addition of generating capacity reflects poor planning and scheduling, as well as failure to place units in operation as planned. Until fairly recently powerplant planning and construction organizations were plagued with frequent reorganizations, which resulted in significantly poorer performance. 9/ In the first 10 months of 1963, for instance, only 352 mw out of a planned 962 mw actually had been placed in operation, 10/ partly due to difficulty in getting newly designed 100 mw units to operate properly. Much of the capacity which failed to go into operation in 1963 did go into operation early in 1964 and contributed to making installations in 1964 more than double those of any year since 1959, which also followed immediately upon a poor year.

Since 1959 installed capacity in the Czechoslovak electric power industry has grown much more rapidly than the total expenditures on the industry, as is shown in Figure 2. Over half of the new generating capacity installed in the industry since that date has been in three powerplants, containing 110-mw turbogenerators, construction of which started in 1956. As the cost per kilowatt of constructing these powerplants has been considerably less than the unit cost of older, smaller, less standardized powerplants, the

annual investment in new capacity has grown more slowly since 1956 than in prior years. The decline in the rate of growth in investment thus reflects greater efficiencies in factor inputs, rather than a slowdown in additions to generating capacity.

The long-term trends in investment and capacity in relation to production of electric power do not appear to explain the noticeable drop in the rate of production in 1963. Cumulative capital investment in the electric power industry, although growing less rapidly in the years since 1956 than before, was still adequate to increase the rate of growth of generating capacity because of increasing capital productivity. The increases in generating capacity were, in turn, adequate for continuing the rate of increase in production of electric power under normal conditions. If, as the trends 1956-64 indicate, investment and capacity were adequate for normal growth in production, why did the rate of production fall off in 1963, and why were there shortages of power in that year? The answers must be found in occurrences peculiar to 1963.

II. Determinants of the Level of Production of Electric Power in 1963

A. Underfulfillment of the Goal for Production of Electric Power

Production of electric power in Czechoslovakia in 1963 was about 1.5 billion kwh (or 5 percent) less than planned. The shortfall was attributable in part to the failure of Czechoslovak industry to require more power, and in part to a combination of difficulties in the electric power industry. The major element depressing the growth of production of

electric power in 1963 was the failure of the Czechoslovak industry, which accounts for over three-fourths of total final consumption, to require more power. Industrial output declined by 3 percent, compared to an increase of 4 percent the previous year. The underfulfillment of industry's production goals more than adequately explains the 1.5 billion kwh underfulfillment in production of electric power.*

The most obvious obstacle to the effective operation of the electric power industry was the poor water flows in Czechoslovak rivers, which reduced production at hydroelectric powerplants to 0.8 billion kwh below normal. As hydro power is used to meet peak loads in the Czechoslovak power system, the ability of Czechoslovak hydroelectric powerplants to put out only 340 megawatts (mw) during peak operation, instead of the 500 mw which was the normal peak load capability, caused considerable load-cutting at times of peak load. 11/

The lower production at hydroelectric powerplants would normally have been balanced by higher production at thermal powerplants, but a severe winter hampered coal shipments. Moreover, Czechoslovak thermal powerplants rely in large part upon lignite, with a high moisture content, which froze and could not rapidly be broken out of railway cars, or if already in storage, move up the conveyors from the storage areas to the boilerhouse. 12/

* Table 2 and Figure 3 show the relationship between consumption of electric power by industry and the growth of industrial output in Czechoslovakia.

Table 2

Czechoslovakia: Consumption of Electric Power by Industry and Growth of Industrial Output

Year	Consumption of Electric Power by Industry Million kilowatt-hours a/	Index	Index of Net Output of Industry c/	Electric Power Index Divided by Industry Index	
				Index	Previous Year = 100 d/
1954	9,015	100	100	100	
1955	9,933	110	112	98	98
1956	10,804	120	122	99	101
1957	11,534	128	134	95	97
1958	12,983	144	149	97	101
1959	14,324	159	161	99	102
1960	15,671	174	175	99	100
1961	16,915	188	187	101	101
1962	18,261	203	195	104	103
1963	19,340 b/	214	189	113	109

a. 17/ Includes consumption of power from all sources - from both the electric power industry and from factory powerplants.

b. Increased of 5.9 percent. 18/

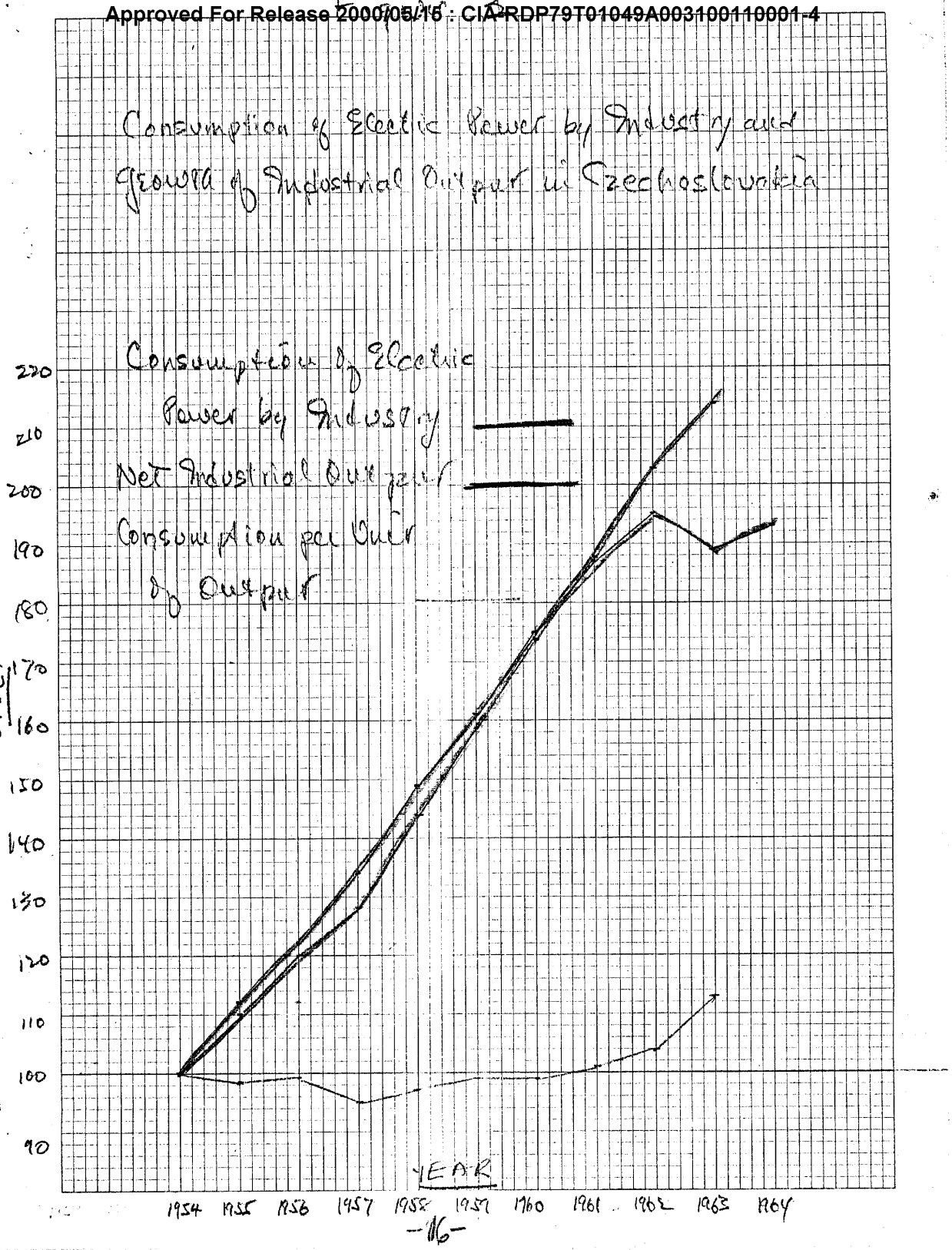
c. 19/

d. Derived from unrounded indexes.

These abnormal situations would have caused no disruption of power supply if there had been sufficient reserve capacity* in the power system. Reserve margins at thermal powerplants steadily decreased from 1956 through 1961, but then increased slightly (by 2 percent) during 1962 and 1963. The margins were adequate in 1961 and 1962 because water and fuel flows were normal. The margin increased in 1963, but not by enough to handle the abnormal situation caused by the severe winter.

Available capacity, and hence reserves, could have been 300 mw higher in 1963 if three new 100 mw units, originally installed in 1963 or earlier in the Tissova, Tusimice, and Novaky thermal powerplants had operated as planned, and had not been removed for various reasons. 13/ The new generating units, designed by the Lenin Works in Plzen in 1957 as 100-mw units and first placed in operation in August, 1960, did not for several years work as expected. 14/ The units vibrated, failed to operate at planned capacity, and, in one case, blew up. 15/ They were redesigned as 110-mw units and have been since 1963 more successful in their operation. 16/

* Reserve capacity of 5-10 percent of peak load is normally needed to cover unforeseen outages of generating equipment. Reserve requirements in 1963 in Czechoslovakia probably exceeded normal requirements because of the severe winter.



B. Relationship of Over-Expenditures of Power to the Power Shortages and the Industrial Decline

It is unlikely that the shortages of electric power, caused in part by the severe winter on the one hand and by the inadequate reserve capacity on the other, had any appreciable depressant effect on industrial output. On the contrary, both the shortages of electric power and the downturn in industrial output might not have occurred were it not for the gross inefficiency in management of inputs to Czechoslovak industry.

In 1963 the consumption of electric power by Czechoslovak industry grew by 6 percent, at the same time that net industrial output was falling by 3 percent. Consequently industry used 9 percent more electric power per unit of industrial output in 1963 than in 1962. Inputs of electric power per unit of industrial output had never before risen more than 3 percent in a year. If this differential of 3 percent between growth in power consumption and industrial output is considered to be the highest normal differential in any year, then 6 percent of the consumption by electric power by industry in 1963 (the difference between the 9 percent differential in 1963 and the previous high differential of 3 percent) must be considered to be an abnormal over-expenditure of electric power by industry. This over-expenditure amounted to 1.2 billion kwh and required (including power station use and transmission line losses) the production of an additional 1.5 billion kwh.

If there had been no over-consumption in 1963, it is probable that production requirements would have been about 1.5 billion kwh lower, in which

case it is likely that there would have been no power shortages, in spite of the shortcomings in the power industry. And in view of the fact that consumption of electric power per unit of industrial output was so much greater than in any previous year, it is also unlikely that it was the power shortage that limited industrial growth.

The increase in the use of electric power per unit of output cannot be explained by substitution of electric power for labor, or for other factors of production, as labor inputs grew 4 percent faster than industrial output, and total factor inputs grew 5 percent faster than industrial output. Decreased efficiency in the face of a decline in industrial activity probably resulted from the organization of Czechoslovak industry. In capitalist countries the labor force probably would have been reduced and efficiency maintained or increased as an adjustment to the recession. It is also impossible to explain the increase in consumption of electric power per unit of industrial output in terms of a structural shift within industry, from less power intensive industries to more power intensive industries. All branches of industry showed a similar, if unequal, increase in consumption of electric power per unit of output. The increase can best be explained as an extreme example of the general decline in input efficiencies in Czechoslovak industry in 1963. It was this general decline in efficiency, which caused the industrial slowdown, not the shortages of electric power. Although available data do not yet permit a precise assessment of whether this general decline in efficiency carried over into 1964 the fact that production of electric power by the electric power industry increased by 8.5 percent in 1964 while net industrial production increased by only about 2 percent suggests a continued high rate of consumption of power per unit of industrial output.

III. Prospects

If the slowdown in growth of production of electric power and the shortages of electric power in 1963 can be explained largely as a result of a combination of events unique to 1963, rather than as a result of long-term secular trends, the likelihood of a repetition of the 1963 situation is not great.

It is, of course, possible that another severe winter would cut production at hydroelectric and thermal electric powerplants, but reserve generating capability is now so much higher that this is not probable. Generating capacity grew by 15 percent in 1964, when six of the redesigned 110-mw units were placed in operation. As of March, 1965, eleven of the units were in operation.[20/] The Czechoslovak experience with the 100-mw units thus paralleled their experience with the 50-mw units, which were introduced in 1954, failed to operate as expected, were redesigned, and since 1958 have been operating satisfactorily. The Lenin Works produced several of the redesigned 110-mw units in 1964 for installation in 1965. In addition, the works tested the prototype of a new 200-mw unit, which is expected to go into operation in 1965. Even if, as seems likely, the 200-mw units are not perfected for another three or four years, the serial production and installation of the 110-mw units should permit a continuation of the trend of the last five years, during which new capacity has been built in an increasingly economic manner, and has grown substantially faster than the demand for power.

The Czechoslovak electric power industry now has sufficient generating capacity reserve that abnormalities such as were experienced in 1963 will not bring shortages of power. In addition, since the fall of 1964 the Czechoslovak power network has been connected to the West Ukraine network of the USSR and can import up to 2 billion kwh a year to meet peak demands when needed. It seems unlikely, therefore, that the shortages of 1963 will again occur in the foreseeable future.

APPENDIX A

Production of Electric Power in Czechoslovakia
1954-1964 a/

Year	Total Production (million kwh)	Production by Electric Power Industry (million kwh)	Production by Electric Power Industry As Percent of Total Production
1954	13,610	9,029	66
1955	15,013	10,257	68
1956	16,591	11,600	70
1957	17,720	12,362	70
1958	19,620	13,777	70
1959	21,884	15,780	72
1960	24,450	18,168	74
1961	26,962	20,377	76
1962	28,732	21,936	76
1963	29,861	22,332	75
1964	32,000	24,229	76

a. 21/

APPENDIX A

Source References

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